

## METHOD AND DEVICE FOR COLOR DATA GENERATION

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a method and device  
5 of generating color data for color image formation by  
converting image data of three colors of cyan, magenta, and  
yellow, representing a color image to be formed, into color  
data for four colors including cyan, magenta, and yellow,  
and black.

#### 10 2. Description of Related Art

Conventional color image forming devices such as  
printers and copy machines generally form color images on a  
recording paper using ink or toner of the four colors of  
cyan (C), magenta (M), yellow (Y), and black (K).

15 In this image forming process, a computer or scanner,  
for example, inputs image data that includes color data for  
the three colors of red (R), green (G), and blue (B) into  
the color image forming device. The image forming device  
then converts this image data to image data of the three  
20 colors of cyan (C), magenta (M), and yellow (Y). The image  
forming device then converts a portion of or all overlapping  
portions in which the three-color data overlap into black  
(K) data, thereby generating four-color data for color image  
formation.

25 For example, as shown in Fig. 1, a color data

generating device 21 in this type of color image forming device can include a selecting unit 22 for selecting, as black data K, the minimum value among color data C1 (cyan), M1 (magenta), and Y1 (yellow); and a subtracter 23 for  
5 correcting each color data C1, M1, and Y1 by subtracting the black data K from each color data C1, M1, and Y1. The color data generating device 21 outputs the black data K, which is outputted from the selecting unit 22, and the color data C2, M2, and Y2 corrected by the subtracter 23 as the color data  
10 (C2, M2, Y2, K) for color image formation.

The generated color data C2, M2, Y2, and K is used to determine the amount of ink or toner for each color used in forming the color image.

#### SUMMARY OF THE INVENTION

15 However, the conventional color data generating device determines the black data K based on the minimum value of the three color values C1 (cyan), M1 (magenta), and Y1 (yellow), regardless of variations in the main color of the image. As a result, the black color can be depicted too  
20 heavily, causing light or weak images too appear messy, or too weakly, causing dark or strong images too lack sufficient contrast, thereby resulting in a decline in the quality of image reproduction and the quality of the product.

For example, when the main color of the image is a  
25 light or weak color such as skin color, the black color

stands out and appears overbearing. When the main color of the image is a dark or strong color such as blue color, the black color can be submerged resulting in insufficient contrast in the image.

5           In view of the foregoing, it is an object of the present invention to provide a color data generating method and a color data generating device for generating color data for color image formation capable of forming images of high quality.

10           In order to attain the above and other objects, the present invention provides a method of generating color data for image formation in a color image forming device by converting data of color values for three colors of cyan, magenta, and yellow, representing a color image to be formed,  
15           into data of color values for four colors of cyan, magenta, yellow, and black. The method includes: preparing a plurality of black data generating tables which have different black data conversion characteristics from one another; receiving a set of color data including color  
20           values for three colors of cyan, magenta, and yellow; extracting a minimum value among the three color values in the received set of color data; selecting a black data generating table dependently on color of the extracted minimum value; and generating a value for black using the  
25           selected black data generating table and based on the

extracted minimum value.

According to another aspect, the present invention provides a color data generating device, provided in a color image forming device, for generating color data for image formation by converting data of color values for three colors of cyan, magenta, and yellow, representing a color image to be formed, into data of color values for four colors of cyan, magenta, yellow, and black. The device includes: a table storage portion; an input portion; an extracting portion; a table selecting portion; and a black generating portion. The table storage portion stores a plurality of black data generating tables which have different black data conversion characteristics from one another. The input portion receives a set of color data including color values for three colors of cyan, magenta, and yellow. The extracting portion extracts a minimum value among the three color values in the received set of color data. The table selecting portion selects a black data generating table dependently on color of the extracted minimum value. The black generating portion generates a value for black using the selected black data generating table and based on the extracted minimum value.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the invention will become more apparent from reading the

following description of the preferred embodiments taken in connection with the accompanying drawings in which:

Fig. 1 is a functional block diagram of a conventional color data generating device;

5        Fig. 2(a) is a block diagram showing the overall structure of a color data generating device according to a preferred embodiment of the present invention;

Fig. 2(b) is a functional block diagram of the color data generating device of Fig. 2(a);

10       Fig. 3 is a functional block diagram showing the operations of the UCR processing unit 2;

Fig. 4 is a flowchart showing the operations of the UCR processing unit 2;

Fig. 5(a) is a graph showing the conversion  
15       characteristics of a KCy table 12c;

Fig. 5(b) is a graph showing the conversion characteristics of a KMy table 12m; and

Fig. 5(c) is a graph showing the conversion characteristics of a Kyy table 12y.

20       DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A color data generating device according to a preferred embodiment of the present invention will be described while referring to the accompanying drawings wherein like parts and components are designated by the same reference numerals to  
25       avoid duplicating description.

Fig. 2(a) shows the overall structure of a color data generating device 100 for image formation according to the preferred embodiment. The color data generating device 100 is disposed in a color image forming device (not shown) such as a printer or a copy machine.

The color data generating device 100 includes: a microcomputer 102 and a memory 104, such as ROM or RAM, which is connected to the microcomputer 102. A special logic circuit may be provided in place of the microcomputer 102.

A personal computer, scanner, or the like (not shown) supplies the color data generating device 100 with a set of image data (R, G, B) that is indicative of a color state of a pixel of an image and that has color data for the three colors of red (R), green (G), and blue (B). The color data generating device 100 converts this image data (R, G, B) to color data (C3, M3, Y3, K3) for image formation that includes the four colors of cyan (C3), magenta (M3), yellow (Y3), and black (K2), and subsequently outputs this color data (C3, M3, Y3, K2) to an image forming unit (not shown) in the color image forming device.

As shown in the functional block diagram of Fig. 2(b), the color data generating device 100 includes: a converting unit 1, a UCR (Under Color Rejection) processing unit 2, and an image recording  $\gamma$  table 3. The image recording  $\gamma$  table 3

is configured in the memory 104. The converting unit 1 and the UCR processing unit 2 are implemented through a computational process executed by the microcomputer 102 by using the memory 104.

5       The converting unit 1 uses a preset lookup table (LUT), which is stored in the memory 104, to convert RGB image data (R, G, B) representing a color pixel into a set of three-color data (C1, M1, Y1) for cyan, magenta, and yellow that have a complementary color relationship with the RGB image  
10      data.

      The UCR processing unit 2 converts the three-color data set (C1, M1, Y1) into a set of four-color data (C2, M2, Y2, K1) for cyan, magenta, yellow and black in a manner according to the present embodiment.

15       The image recording γ table 3 is used to convert the four-color data set (C2, M2, Y2, K1) into another four-color data set (C3, M3, Y3, K2) for cyan, magenta, yellow, and black in order to adjust image characteristics such as brightness values and reflection density values for printing  
20      on a recording medium. Receiving the color data set (C3, M3, Y3, K2), the image forming unit in the image forming device (not shown) forms a color image on a recording medium by ejecting ink of the four colors in amounts that are determined based on the four-color data C3, M3, Y3, and K2.

25       Next, the construction and operations of the UCR

processing unit 2 will be described with reference to Figs. 3 and 4.

Fig. 3 represents the function blocks of the UCR processing unit 2.

5       As shown in Fig. 3, the UCR processing unit 2 includes: a selecting unit 11, a storing unit 12, and a correcting unit 13. The storing unit 12 is configured in the memory 104. The selecting unit 11 and the correcting unit 13 are implemented through a computational process of  
10      Fig. 4 executed by the microcomputer 102.

      The storing unit 12 stores three types of black data generating tables, that is, a KCy table 12c, a KMy table 12m, and a KYy table 12y. The KCy table 12c is used for generating black data K1 based on color data C1 inputted  
15      from the converting unit 1. The KMy table 12m is used for generating black data K1 based on the color data M1 inputted from the converting unit 1. The KYy table 12y is used for generating black data K1 based on the color data Y1 inputted from the converting unit 1.

20       The selecting unit 11 extracts a minimum value k from among the three values C1, M1, and Y1 in the color data set (C1, M1, Y1) indicative of one pixel inputted from the converting unit 1. That is,  $k = \min(C1, M1, Y1)$ . If the minimum value k is color data C1 ( $k = C1$ ), then the KCy  
25      table 12c is selected for generating black data K1. If the



minimum value  $k$  is color data  $M1$  ( $k = M1$ ), then the  $KMy$  table 12m is selected for generating black data  $K1$ . If the minimum value  $k$  is color data  $Y1$  ( $k = Y1$ ), then the  $KYy$  table 12y is selected for generating black data  $K1$ . The  
5 black data  $K1$  is generated using the selected table 12c, 12m, or 12y.

The correcting unit 13 corrects each color data  $C1$ ,  $M1$ , and  $Y1$  by subtracting the generated black data  $K1$  from each color data  $C1$ ,  $M1$ , and  $Y1$ . Color data  $C2$  ( $C1-K1$ ),  $M2$  ( $M1-K1$ ), and  $Y2$  ( $Y1-K1$ ) obtained through the correction by the  
10 correcting unit 13, and the black data  $K1$  generated by using one of the  $KCy$  table 12c,  $KMy$  table 12m, or  $KYy$  table 12y are outputted as a set of image data ( $C2$ ,  $M2$ ,  $Y2$ ,  $K1$ ) to the image recording  $\gamma$  table 3 (Fig. 2(b)).

15 Next, steps in the computational process executed by the microcomputer 102 for implementing the functions of the selecting unit 11 and the correcting unit 13 will be described with reference to the flowchart of Fig. 4.

As shown in Fig. 4, the UCR processing unit 2 reads  
20 one set of color data ( $C1$ ,  $M1$ ,  $Y1$ ) from the converting unit 1 in  $S11$ . The color data ( $C1$ ,  $M1$ ,  $Y1$ ) represents a pixel in a color image to be formed by the image forming device (not shown) in which the color data generating device 100 is incorporated.

25 In  $S12$ , the UCR processing unit 2 extracts the

smallest value  $k$  from among the color values  $C1$ ,  $M1$ , and  $Y1$  in the data set  $(C1, M1, Y1)$  that is read in  $S11$ . Color data  $C1$ ,  $M1$ , or  $Y1$  that corresponds to the minimum value  $k$  is selected as a parameter for choosing one of the  $KCY$  table  
5  $12c$ ,  $KMY$  table  $12m$ , and  $KYY$  table  $12y$ .

In  $S13$  one of the  $KCY$  table  $12c$ , the  $KMY$  table  $12m$ , and the  $KYY$  table  $12y$  that corresponds to the parameter  $C1$ ,  $M1$ , or  $Y1$  selected in  $S12$  is chosen as a black data generating table to be used for the present pixel. Then,  
10 the selected black data generating table  $12c$ ,  $12m$ , or  $12y$  is referred to, and a black value  $K1$  that corresponds to the parameter  $C1$ ,  $M1$ , or  $Y1$  is selected from the selected black data generating table  $12c$ ,  $12m$ , or  $12y$ .

After generating the black data  $K1$  in  $S13$ , corrected  
15 color data  $C2$ ,  $M2$ , and  $Y2$  are calculated in  $S14$  by subtracting this black data  $K1$  from the color data  $C1$ ,  $M1$ , and  $Y1$ , respectively. That is, in  $S13$ , the following equations are calculated:

$$\begin{aligned} C2 &= C1 - K1, \\ 20 \quad M2 &= M1 - K1, \\ Y2 &= Y1 - K1. \end{aligned}$$

In  $S15$  the values  $C2$ ,  $M2$ , and  $Y2$  calculated in  $S14$  and the black value  $K1$  calculated in  $S13$  are outputted together as a set of image data  $(C2, M2, Y2, K1)$  to the image  
25 recording  $\gamma$  table 3, and the process for the subject pixel

ends.

Next, the KCy table 12c, the KMy table 12m, and the KYy table 12y will be described with reference to Figs. 5(a) - 5(c).

5           It is noted that when cyan data C1 is selected in S12 as the minimum value among the three color data C1, M1, and Y1 in the received data set (C1, M1, Y1) depicting one pixel, then it is known that the main color of this pixel is a combination of yellow and magenta, and therefore that this  
10 pixel represents a light or weak color such as a skin color or the like. It is noted that black color tends to stand out on light- or weak-color images and therefore that color images that have yellow and magenta combination as their main color are likely to appear cluttered. The KCy table  
15 12c is prepared to cope with such images that have yellow and magenta as their main color. The KCy table 12c is selected in S13 when the minimum value k in the inputted color data set (C1, M1, Y1) is the value C1 (cyan).

When yellow data Y1 is selected as the minimum value  
20 in the received color data set (C1, M1, Y1), then it is known that the main color of this pixel is a combination of cyan and magenta, and therefore that this pixel represents dark or strong color such as blue, burgundy (reddish-purple), or the like. It is noted that color images having cyan and  
25 magenta combination as their main color have such

characteristics that black color tends to be lost in the main color, resulting in the color images lacking sufficient contrast. The KYy table 12y is prepared to cope with such images that have cyan and magenta as their main color. The  
5 KYy table 12y is selected in S13 when the minimum value k in the inputted color data set (C1, M1, Y1) is Y1 (yellow).

When magenta data M1 is selected as the minimum value in the received color data set (C1, M1, Y1), then it is known that the main color of this pixel is a combination of  
10 cyan and yellow, and therefore that this pixel represents medium-dark or medium-strong color such as green or the like. It is noted that color images having cyan-and-yellow combination as their main color have characteristics intermediate between the color images having yellow-and-magenta combination as their main color and the color images  
15 having cyan-and-magenta combination as their main color. The KMy table 12m is prepared to cope with such images that have cyan and yellow as their main colors. The KMy table 12m is selected in S13 when the minimum value k in the  
20 inputted color data set (C1, M1, Y1) is M1 (magenta).

Fig. 5(a) is a graph showing the conversion characteristics of the KCy table 12c. In Fig. 5(a), the horizontal axis represents the value of the inputted color  
data C1 (minimum value k) serving as the target of  
25 conversion, while the vertical axis represents the value of

black data K1 that is to be outputted through the conversion. Each of these data values represents a color value in a 256-gradation range.

Fig. 5(b) is a graph showing the conversion characteristics of the KMy table 12m. In Fig. 5(b), the horizontal axis represents the value of the inputted color data M1 (minimum value k) serving as the target of conversion, while the vertical axis represents the value of black data K1 that is to be outputted through the conversion. Each of these data values represents a color value in a 256-gradation range.

Fig. 5(c) is a graph showing the conversion characteristics of the KYy table 12k. In Fig. 5(c), the horizontal axis represents the value of the inputted color data Y1 (minimum value k) serving as the target of conversion, while the vertical axis represents the value of black data K1 that is to be outputted through the conversion. Each of these data values represents a color value in a 256-gradation range.

As shown in Fig. 5(a), the KCy table 12c is configured to not generate the black data K1 when the input color data C1 is less than or equal to a first prescribed limit value P. As shown in Fig. 5(c), the KYy table 12y is configured to not generate the black data K1 when the input color data Y1 is less than or equal to a second prescribed limit value Q

that is less than the first prescribed limit value P. As shown in Fig. 5(b), the KMy table 12m is configured to not generate the black data K1 when the input color data M1 is less than or equal to a third prescribed limit value S that is between the first limit value P and the second limit value Q. It is noted, however, that depending on the type of recording medium to be used and a desired image to be printed, the third limit value S can be set closer to the first limit value P, closer to the second limit value Q, or equivalent to either the first limit value P or second limit value Q.

These limit values P, S, and Q are set because if black data K1 of greater than zero were generated when the minimum value k of the color data set (C1, M1, Y1) is less than the corresponding limit value P, S, or Q, the black color would appear extremely harsh, thereby greatly degrading the color hue appearance of the image. By generating black data K1 of zero when the minimum value k of the color data (C1, M1, Y1) is less than or equal to the corresponding limit value P, S, or Q, it is possible to form a high-quality color image without degrading the color hue appearance of the image.

As shown in Figs. 5(a) - 5(c), in each of the KCy table 12c, KMy table 12m, and KYy table 12y, the graph curve indicative of the correspondence between input data C1, M1,

and Y1 (minimum value k) and output data K1 has such characteristics that the value of the black data K1 increases as the corresponding value C1, M1, or Y1 increases in a range A, which is defined between its limit value P, S, or Q and a predetermined maximum value 255 in the 256-gradation range. Accordingly, the appropriate value of black data K1 can be generated according to variations in the density of the minimum value k of C1 (cyan), M1 (magenta), or Y1 (yellow).

10           It is noted, however, that the KCy table 12c, KMy table 12m, and KYy table 12y have different graph curves from one another. In this way, it is possible to generate black data K1 of values that can appropriately adjust the image contrast and image quality according to the main color  
15   of the image.

          It is noted that even when input color data C1, M1, or Y1 is larger than the corresponding limit value P, S, or Q, the image quality will still be affected by the value of black data K1 when the input color data C1, M1, or Y1 is a  
20   relatively small value. Accordingly, each graph curve is set so that while the input value C1, M1, or Y1 has a relatively small value in the range A, the value of the black data K1 changes effectively at a relatively high  
25   changing rate, in accordance with the change in the corresponding input value C1, M1, or Y1, in a corresponding

specific manner that is determined dependent on the corresponding main color. More specifically, the range A greater than the limit value P, S, or Q has a first range A1 near to the limit value P, S, or Q; a second range A2 near to the maximum value 255; and a third range A3 intermediate  
5 between the ranges A1 and A2. In the range A1, the value of the black data K1 changes effectively at a relatively high changing rate, in accordance with change in the corresponding input value C1, M1, or Y1, in a corresponding  
10 specific manner.

It is also noted that when the input data C1, M1, or Y1 becomes near to the maximum value 255, the total amount of ink for the three colors C1, M1, and Y1 will increase. Accordingly, these graph curves are set to control the  
15 overall amount of ink used. That is, the rate of change in the graph curve decreases as the color data value C1, M1, or Y1 increases toward the predetermined maximum value 255. In other words, each graph curve is set so that the rate of change in the curve in the range A2 is smaller than the rate  
20 of change in the curve in the range A1. In this example, each graph curve is set so that the rate of change in the curve in the range A2 is smaller than the rate of change in the curve in the range A3, and the rate of change in the curve in the range A3 is smaller than the rate of change in  
25 the curve in the range A1.



Accordingly, even when the input data C1, M1, or Y1 approaches 255, the output data K1 will become 200 or less. In this way, it is possible to reduce the amount of ink for the black data K1, while maintaining gradation by allowing the black data K1 to increase as the input data C1, M1, or Y1 increases. Hence, conversion to the black data K1 using the tables 12c, 12m, or 12y can control the overall amount of ink to be ejected onto the recording medium, thereby forming images on the recording medium that are not sticky. Ink ejected onto the recording medium dries quickly.

As described above, when color image data (C1, M1, Y1) representing a color image is read in S11, the minimum value from among the color values C1, M1, and Y1 is selected in S12. Next, in S13, black data K1 is generated using a black data generating table 12c, 12m, or 12y that corresponds to the color of the minimum value  $k = \min(C1, M1, Y1)$  determined in S11. The black data generating tables 12c, 12m, and 12y have different black data conversion characteristics from one another and are associated with the three colors of cyan, magenta, and yellow, respectively. In S14, the black data K1 obtained in S13 is subtracted from each of the color data C1, M1, and Y1 to obtain corrected color data C2, M2, and Y2. In S15, the data C2, M2, and Y2 are outputted along with the black data K1 as four-color data (C2, M2, Y2, K1). Accordingly, it is possible to form

images of high quality, even when the main colors of the images change, by preventing light- or weak-color images from appearing messy due to the black color being depicted too strongly and by preventing dark- or strong-color images from lacking sufficient contrast due to the black color being depicted too weakly.

As described above, with the color data generating device 100 according to the preferred embodiment and having the construction described above, the black data generating table 12c, 12m, or 12y that is suited to the main color of the input image can be selected in S12 and S13. Accordingly, high-quality images with good reproduction can be always formed, even when the main colors of the color images change. That is, it is possible to prevent the representation of the black color from being too harsh and making light- or weak-color images appear messy. It is also possible to prevent the representation of the black color from being too weak and providing insufficient contrast in dark- or strong-color images.

As described above, the main color of an image is determined by color data for two colors that is obtained by excluding the color data  $k = \min (C1, M1, Y1)$  having the minimum value from among the three-color data C1, M1, and Y1. According to the present embodiment, the black data generating table 12c, 12m, and 12y, each of which is

associated with corresponding color data  $k = \min (C1, M1, Y1)$  having the minimum value, is configured to determine an output value of the black data  $K1$  that is suited to the main color of the image and that can adjust the image contrast and image quality suitably. Hence, by selecting a black data generating table 12c, 12m, or 12y in association with the minimum value  $k = \min (C1, M1, Y1)$ , it is possible to select a black data generating table 12c, 12m, or 12y that is suited to the main color of the color image.

For example, when the cyan color data  $C1$  is the smallest among the color data values  $C1, M1$ , and  $Y1$ , then the main color of the pixel is represented mostly by yellow and magenta. Accordingly, if black data of greater than zero were generated when the color data  $C1$  is less than or equal to the first limit value  $P$ , then the black will clutter a resultant image and will degrade the color hue appearance. Hence, according to the present embodiment, by preparing the table 12c of Fig. 5(a) in which black data  $K1$  of zero will be generated when color value  $C1$  is smaller than or equal to the first limit value  $P$ , and by selecting the table 12c when the cyan color data  $C1$  is the minimum value  $k = \min (C1, M1, Y1)$ , it is possible to prevent black data  $K1$  of greater than zero from being generated when the input value  $C1$  is less than or equal to the first limit value  $P$  and therefore the input pixel has primarily yellow

and magenta. Accordingly, a high-quality image can be formed without cluttering the image or degrading the color hue appearances.

When the yellow color data  $Y_1$  is the minimum value among the color data  $C_1$ ,  $M_1$ , and  $Y_1$ , the main color of the pixel is represented by cyan and magenta. It is noted that when color in a color image formed primarily of cyan and magenta is light or weak, black can clutter the color image and degrade its color hue if black data of greater than zero were generated when the color data  $Y_1$  is less than or equal to the second limit value  $Q$ . Hence, according to the present embodiment, by preparing the table 12y of Fig. 5(c) in which black data  $K_1$  of zero will be generated when color value  $Y_1$  is smaller than or equal to the second limit value  $Q$ , and by selecting the table 12y when the yellow color data  $Y_1$  is the minimum value  $k = \min (C_1, M_1, Y_1)$ , black data of greater than zero will not be generated when the input value  $Y_1$  is less than or equal to the second limit value  $Q$  and is indicative of a color image formed primarily of cyan and magenta. Therefore, a high-quality image can be formed without cluttering the image or degrading the color hue appearances.

Black is less noticeable in color images formed primarily of cyan and magenta than in color images formed primarily of yellow and magenta. Therefore, the second

limit value Q is set smaller than the first limit value P.  
It is possible to generate black data of greater than zero  
even when color data Y1 is smaller than the first limit P if  
the color data Y1 is greater than the second limit Q. It is  
5 therefore possible to improve the contrast in color images  
and to expand the range of color density control.

Further, since the amount of black data K1 generated  
is subtracted from the C1, M1, and Y1 color data, images  
that are not sticky can be formed on the recording medium by  
10 controlling the amount of total ink ejected thereon.

Further, color images of a high quality can be formed  
without the images appearing cluttered or degrading their  
color hue appearance, even when the color data for the three  
colors C1, M1, and Y1 are small and form light or weak  
15 colors.

By providing the three tables 12c, 12m, and 12y having  
a one-on-one correspondence with the three colors of cyan,  
magenta, and yellow, it is possible to generate black data  
K1 by selecting one of the tables 12c, 12m, and 12y that is  
20 suited to the main color of the image, which is dependent on  
the variations in the combinations of the densities of the  
three colors, thereby forming images of high quality with  
good reproduction.

While the invention has been described in detail with  
25 reference to the specific embodiment thereof, it would be

apparent to those skilled in the art that many modifications and variations may be made therein without departing from the spirit of the invention, the scope of which is defined by the attached claims.

5           For example, in the embodiment described above, the three types of tables 12c, 12m, and 12y having different conversion characteristics, shown in Figs. 5(a) - 5(c), are selectively used as a black data generating table for converting the minimum value of the inputted data C1, M1,  
10   and Y1 into black data K1. However, the conversion characteristics of these tables 12c, 12m, and 12y are not limited to the characteristics shown in Figs. 5(a) - 5(c), provided that the tables 12c, 12m, and 12y are associated with the color data C1, M1, and Y1 to prevent the  
15   representation of the black color K1 from being too strong relative to light- or weak-color images and making the images feel cluttered and to prevent the representation of the black color K1 from being too weak relative to dark- or strong-color images and giving the images insufficient  
20   contrast.

          Further, it is unnecessary to prepare three black data generating tables 12c, 12m, and 12y corresponding to all of the three types of color data C1, M1, and Y1. For example, it is possible to prepare only the two tables: KCy table 12c  
25   and KYy table 12y. In this case, when the minimum value

among the input values  $C1$ ,  $M1$ , and  $Y1$  is  $M1$  in  $S12$ , one of the  $KCY$  table 12c and  $KYY$  table 12y is selectively used in place of the  $KMY$  table 12m. This is because an image having magenta value  $M1$  as the minimum value  $k = \min (C1, M1, Y1)$  has characteristics intermediate between the characteristics of another image having cyan value  $C1$  as the minimum value  $k = \min (C1, M1, Y1)$  and still another image having yellow value  $Y1$  as the minimum value  $k = \min (C1, M1, Y1)$ . In this modification, it is preferred that which one of the tables 12c and 12y is used in correspondence with the minimum value  $M1$  is determined as fixed in advance. The memory 104 is stored with data indicative of the fixed one of the tables 12c and 12y to be used in correspondence with the minimum value  $M1$ . This ensures that the previously-determined, same table 12c or 12y will be used in  $S13$  every time when the minimum value is determined as  $M1$  in  $S12$ . It is possible to continuously form images of high quality with good reproduction.

20